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Topical Report

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Nirmala Kannankutty, Author

Division of Science Resources Studies
Directorate for Social, Behavioral, and Economic Sciences

National Science Foundation

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National Science Foundation
Rita R. Colwell
Director

Directorate for Social, Behavioral, and Economic Sciences
Bennett I. Bertenthal
Director

Division of Science Resources Studies
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Program Director

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SESTAT AND NIOEM: TWO FEDERAL DATABASES PROVIDE COMPLEMENTARY INFORMATION ON THE SCIENCE AND TECHNOLOGY LABOR FORCE

Several Federal statistical agencies collect information on the scientists and engineers in the labor force – two of the principal agencies that do so are the National Science Foundation (NSF) and the Bureau of Labor Statistics (BLS). Each has compiled this information in individual databases; the NSF has the Scientists and Engineers Statistical Data System (SESTAT) and BLS has the information from the National Industry-Occupation Employment Matrix (NIOEM). Taken together, these two databases provide a more comprehensive picture of the science and technology (S&T) labor force than has previously been available.

NSF's SESTAT

The National Science Foundation conducts three surveys of individuals in order to compile information on persons with a bachelor's degree or higher that represent different components of the S&T labor force. The National Survey of College Graduates (NSCG) gathers information for a sample of persons who reported having earned a bachelor's or above at the time of the 1990 decennial census. It includes science and engineering (S&E) college graduates (bachelor's and above) or those without such training, but with S&E occupations. The National Survey of Recent College Graduates (NSRCG) samples the population of persons who have earned S&E bachelor's and master's degrees since 1990. The Survey of Doctorate Recipients (SDR) is a longitudinal study of persons who have earned S&E doctorates in the U.S. The information from these three surveys has been integrated to form the SESTAT (Scientists and Engineers Statistical Data) system, which is available for public use at http://sestat.nsf.gov. The SESTAT integrated database, with very few exceptions, represents that part of the science and engineering population who either received a college degree (bachelor's or higher) in an S&E field or those who work in an S&E occupation with a bachelor's degree or higher in any field. SESTAT can be used to find demographic, occupational, and educational information on most of the scientists and engineers in the U.S.[1]

BLS's NIOEM

Occupational employment statistics are collected by the BLS with three different surveys. A large majority of the information is collected through the Occupational Employment Statistics survey, which collects data on wage and salary workers by industry in nonfarm establishments.[2] This survey is administered to business establishments rather than to individuals. With this type of collection method, BLS is able to produce statistics on the number of positions held by the employed labor force, by detailed occupational field and by industry.

Additionally, BLS also supports the Current Population Survey (CPS) and the Current Employment Survey (CES). The CPS, a monthly household survey, provides information on the employment and unemployment experience of persons living in the U.S. The CES, also a monthly survey, provides information on hours and earnings estimates of the employed population as provided by business establishments. The CPS and CES fill in some of the gaps in coverage by the OES, such as farm, self, and family employment. These three data sources are combined to produce the National Industry-Occupation Employment Matrix.

The NIOEM provides information on total employment by occupation and industry. It includes establishments in all sectors of the economy, all members of the S&T labor force at all levels of educational attainment (including those below the bachelor's level) and all academic disciplines. The NIOEM does not contain any demographic or educational attainment data on individuals. Detailed information on the NIOEM can be found at http://www.bls.gov/asp/oep/nioem/empiohm.asp.

Table 1 is a summary of the data available from these two major statistical databases.

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[1] For a more complete description of the SESTAT integrated database and data access system, see NSF 99-337 "SESTAT: A Tool for Studying Scientists and Engineers in the United States."

[2] The OES database excludes certain portions of the working population because of its establishment base. The exclusions are farm employment, self-employed persons, and anyone not working for wages and salaries, such as family enterprises.

Table 1. Data characteristics of NIOEM and SESTAT		
Data Characteristics	**Bureau of Labor Statistics** **NIOEM**	**National Science Foundation** **SESTAT**
Scientists and Engineers Both agencies use standard definitions for occupational field, so data are comparable	The number of positions held by all employed persons, by detailed occupational field. Includes data on employed persons who are in occupations that may not require a bachelor's degree, such as technologists or technicians.	All persons with at least a bachelor's degree in S&E or those in S&E occupations, by detailed occupational field. NSF primarily collects data on scientists and engineers with less emphasis on other technical workers.
Periodicity	Data are collected every year and reported periodically.	Data are collected every two years and reported periodically.
Unit of reference for surveys	Data are collected from establishments, with some supplements collected from individuals.	Data are collected from individuals.
Educational information	Not available on the matrix.	Degree fields and levels are available.
Demographic information	Not available on the matrix.	Available.
Occupational information	Data on standard occupational categories are available.	Data on standard occupational categories are available. For categories considered "science or engineering" by NSF, there is more detail. For non-S&E categories, data tend to be aggregated.
Industry information	Data on employment by standard industrial classifications are available.	Employer's name is collected, but not reported. Major sectoral information (state/local government, Federal government, industry, academia, etc.) is reported. More detail is available for academic employment, but not for the government and industrial sectors. Employer's main business type has been collected since 1997.

SOURCE: Bureau of Labor Statistics, National Industry-Occupation Employment Matrix (NIOEM); National Science Foundation, Division of Science Resources Studies, SESTAT (Scientists and Engineers Statistical Data System).

THE S&T LABOR FORCE

There are nine major occupational groups[3] that the U.S. labor force fits into:

1. Executive, administrative, and managerial occupations
2. Professional specialty occupations
3. Technicians and related support occupations
4. Marketing and sales occupations
5. Administrative support occupations, including clerical
6. Service occupations
7. Agriculture, forestry, fishing and related occupations
8. Precision production, craft, and repair occupations
9. Operators, fabricators and laborers

For the most part, the S&T labor force can be found in a few subgroups under the first three major categories. However, persons trained in S&T fields are found in all of the major occupational categories. The nine categories listed above can be further broken out into subcategories. The NIOEM contains employment data for each of the subgroups. SESTAT also collects data on individuals in each of the subgroups, but only for those persons with S&E degrees and/or S&E occupations.

Table 2 lists the total employment in the NIOEM occupational subgroups that are most likely to include S&T workers. Although the list seems relatively complete, it shows only the number of workers whose current occupation is an NIOEM category associated with S&T.

Table 2. Employed persons from NIOEM 1996 in occupational categories related to S&T	
Major Occupational Group	Number
Executive, administrative and managerial occupations	
Engineering, science, and computer systems managers.....................................	343,000
Professional specialty occupations	
Engineers..	1,382,000
Architects and surveyors..	212,000
Life scientists..	180,000
Computer, mathematical, & operations research occupations...........................	1,028,000
Physical scientists...	207,000
Social scientists..	263,000
Health diagnosing occupations...	877,000
Health assessment and treating occupations..	2,684,000
Technicians and related support occupations	
Health technicians and technologists..	2,301,000
Engineering and science technicians and technologists.....................................	1,236,000
Technicians, except health and engineering and science	
(i.e. computer programmers)...	1,082,000

NOTES: All values have been rounded to the thousands. There was only one subcategory under "Executive, administrative and managerial occupations" that was obviously S&T-related, and that group is shown here. However, it is very likely that there are S&E workers in other subcategories in this group, such as "general managers and top executives" or "government chief executives and legislators."

SOURCE: Bureau of Labor Statistics, National Industry-Occupation Employment Matrix 1996.

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[3] The nine groups listed here are part of the Standard Occupational Classification System (SOC), which is a U.S. government standard. The SOC was developed through an interagency committee headed by the Office of Management and Budget. The SOC system is used by all the Federal agencies that collect employment and occupational data, and was meant to provide comparability of data among different Federal statistical agencies. Both the SESTAT and NIOEM databases use the SOC to categorize occupations. The SOC is currently being revised in preparation for the 2000 decennial census. Futher information on the SOC can be found at http://www.bls.gov/soc/soc_home.htm.

It does not include the many people who have S&T training, but are in non-S&T jobs. For example, there are many persons with S&T backgrounds who are top-level managers in industry or government who are not captured in the "engineering, science, and computer systems managers" category; there are also S&T-trained individuals who are artists, writers, teachers, farmers or service personnel. None of them are included in the partial listing of subcategories shown in Table 2, although they are part of the total employment represented by the NIOEM. The NIOEM categories do include the technician/technologist group, as well as persons in S&T occupations where a bachelor's degree is not customarily required; these individuals are not represented in the SESTAT database.

COMPARISONS AND CONTRASTS

A close examination of the NIOEM and SESTAT shows that while there are many differences that exist between these two data sources, the data available on the S&T portion of the labor force in each of these systems are complementary. Table 3 contains a comparison of these two databases at aggregate levels, by major occupational category. In 1996, total occupational employment, in S&T as well as in other fields, as estimated by NIOEM was 132.4 million. NSF estimates that in 1995 (the closest data collection date to the NIOEM estimate), there were 10.1 million persons with science or engineering occupations, or with science or engineering degrees but working in non-S&E occupations. These totals are not comparable – the NIOEM value reflects total employment (defined by the number of positions) whereas the NSF value includes only employment of individuals with S&E degrees and/or S&E occupations.

If the comparison of these two datasets is concentrated on the S&T-related categories, the similarities between the databases becomes more evident. Column A in the table shows the aggregate occupational employment for specific categories as determined from NIOEM. In Column B, the corresponding values from the NSF SESTAT integrated database are shown. Because individuals may hold more than one job, and many in the SESTAT system do hold multiple jobs, the actual number of positions that these 10.1 million persons hold is 11.2 million positions. The values in Column D of the table show the number of positions held by the SESTAT population. In Column E of the table, the percentage difference between the NIOEM (Column A) and SESTAT (Column D) values

for the S&T-related categories of occupations are shown. These categories are where most of the S&T labor force, as defined by occupation, are likely to be found. For four of the principal science and engineering occupational categories (which *usually* require the bachelor's degree) – engineers, computer occupations, physical scientists, and social scientists[4] – the NIOEM and SESTAT employment data are close, with the differences between the databases for these categories at a maximum of 13 percent. For the fifth principal S&E category, life scientists, the difference is 35 percent.

For the remaining highlighted categories, the NIOEM and SESTAT data are widely divergent. There are two primary explanations for the divergence: coverage of different types of occupations within categories, and coverage of people with different types of educational backgrounds within categories. For example, in the categories of "Teachers, secondary school" and "College and university faculty", the SESTAT values are much smaller. In this case, the NIOEM values are for *all* teachers and faculty; the SESTAT values are only for those who teach in science or engineering settings or departments, or those who teach in other departments, but have at least a bachelor's degree in science or engineering. In some of the other categories where there is a divergence, such as in the "technician and technologist" categories, the SESTAT values are smaller, most likely as a result of the fact that the SESTAT surveys do not collect information on persons who have not attained a bachelor's degree.

SUMMARY AND IMPLICATIONS

SESTAT and NIOEM each provide some information on components of the S&T labor force. The NIOEM data give a broad view of the demand reported by establishments in the U.S. (What are the jobs that are available?); the SESTAT data give a more detailed view of the supply side reported by bachelor's and above scientists and engineers employed in the labor force (Who are the persons available to fill those jobs?). One would like to have accurate measures of the complete S&T labor force from a single comprehensive source. An alternative would be multiple complementary sources. The latter case is close to being achieved with the

[4] The 1993 National Survey of College Graduates (NSCG) represents all persons who reported having earned a bachelor's degree or above on the 1990 decennial census. For these five categories of occupations, the NSCG data showed that at least two-thirds of the persons who hold these occupations also held a natural science, social science, or engineering degree.

Table 3. A comparison of NIOEM and SESTAT					
Occupational Group	**1996 NIOEM**	**1995 SESTAT principal job**	**1995 SESTAT second job**	**1995 SESTAT positions (B+C)**	**Percent difference (D-A)/A**
	Column A	Column B	Column C	Column D	Column E
Total, all occupations............................	**132,353,000**	**10,115,000**	**1,119,000**	**N/A**	
Total, all positions..............................	**132,353,000**	**10,115,000**	**1,119,000**	**11,234,000**	
Executive, administrative, and managerial occupations............	**13,542,000**	**1,963,000**	**76,000**	**2,039,000**	
Managerial and administrative occupations..................................	9,539,000	1,403,000	40,000	1,443,000	
Engineering, science, and computer systems managers (NIOEM category only).........................	343,000	N/A	N/A	N/A	
Management support occupations	4,003,000	391,000	20,000	411,000	
OTHER management related occupations (NSF category only).............................	N/A	169,000	16,000	185,000	
Professional specialty occupations............................	**18,173,000**	**5,439,000**	**520,000**	**5,959,000**	
Engineers..............................	1,382,000	1,210,000	32,000	1,242,000	-10.1%
Architects and surveyors............................	212,000	43,000	3,000	46,000	-78.3%
Life Scientists............................	180,000	232,000	11,000	243,000	35.0%
Computer, mathematical, and operations research occupations...............	1,028,000	942,000	46,000	988,000	-3.9%
Physical scientists............................	207,000	228,000	6,000	234,000	13.0%
Social scientists............................	263,000	239,000	43,000	282,000	7.2%
Social, recreational, and religious workers...................	1,469,000	307,000	32,000	339,000	
Lawyers and judicial workers...................	699,000	359,000	16,000	375,000	
Teachers, librarians, and counselors........................	6,565,000	1,152,000	207,000	1,359,000	
College and university faculty............................	864,000	423,000	137,000	560,000	-35.2%
Health diagnosing occupations...................	877,000	418,000	45,000	463,000	-47.2%
Health assessment and treating occupations.......................	2,684,000	165,000	30,000	195,000	-92.7%
Writers, artists, and entertainers...................	1,726,000	144,000	49,000	193,000	
All other professional workers...................	880,000	N/A	N/A	N/A	
Technicians and related support occupations.......................	**4,618,000**	**485,000**	**39,000**	**524,000**	
Health technicians and technologists......................	2,301,000	113,000	16,000	129,000	-94.4%
Engineering and science technicians and technologists..............	1,236,000	167,000	9,000	176,000	-85.8%
Technicians, except health, engineering and science.................	1,082,000	205,000	14,000	219,000	-79.8%
Marketing and sales occupations.......................	**14,633,000**	**926,000**	**138,000**	**1,064,000**	
Administrative support occupations, including clerical..................	**24,019,000**	**396,000**	**34,000**	**430,000**	
Service occupations.......................	**21,294,000**	**256,000**	**68,000**	**324,000**	
Agriculture, forestry, fishing, and related occupations..................	**3,785,000**	**80,000**	**37,000**	**117,000**	
Precision production, craft, and repair occupations...............	**14,446,000**	**141,000**	**24,000**	**165,000**	
Operators, fabricators, and laborers..........................	**17,843,000**	**87,000**	**9,000**	**96,000**	
Other occupations (NSF category only).............................	**N/A**	**342,000**	**174,000**	**516,000**	

NOTE: The NIOEM values in the table refer to total occupational employment in the United States. The SESTAT values refer only to employment of individuals with science or engineering degrees and/or occupations. All values in the table have been rounded to the thousands. Percentage differences in Column E are only shown for those categories with S&T-related occupations. N/A = not applicable.

SOURCE: Bureau of Labor Statistics, National Industry-Occupation Employment Matrix (NIOEM) 1996; National Science Foundation, Division of Science Resources Studies, SESTAT (Scientists and Engineers Statistical Data System) 1995.

SESTAT and NIOEM data, with some limitations. For example, although NIOEM includes employment data on technologists and technicians, complementary SESTAT data cannot be found for a large number of persons holding these jobs because they do not hold bachelor's degrees. The converse situation arises with regard to managers of the scientific and engineering enterprise: SESTAT can be used to identify scientists and engineers who are managers, but these people cannot be mapped into one specific category in the NIOEM.

Both SESTAT and NIOEM contribute to understanding the human resources required for science and technology in the U.S. While NIOEM continues to provide information on the aggregate demand for workers, as defined by the establishments that employ them, SESTAT aids in the analysis of how individuals move into those positions. SESTAT shows that many people with S&E training have dispersed to other parts of the non-S&T labor force.